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ABSTRACT

In this study of cooperative behavior and its antecedents, the main experimental tool was a two-person, two-choice game. The subjects, 80 Negro males ranging in age from 4 1/2 to 6 years, could choose either to cooperate by giving a piece of candy or not to cooperate by refusing to give a piece of candy to the other child during an acquisition phase (the first 30 cooperative responses made) and an extinction phase of 30 trials. N-length was defined as the number of nonreinforced trials spaced between reinforced trials and intertrial reinforcement (ITR), introduced between regularly scheduled trials. The subjects were divided into four groups of 20 each. The first three groups were given 50% reinforcement with the nonreinforced trials spaced between reinforced trials and ITR in N-lengths of 1, 2, and 3. The fourth group received continuous 100% reinforcement. This last group was found to be least resistant to extinction. The group with N-length of 1 was most resistant to extinction. It was theorized that N-lengths beyond 1 inhibit cooperative responses since the subject more readily realizes that his cooperation is not being reciprocated. (MH)

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THE EFFECT OF N-LENGTH ON THE DEVELOPMENT OF COOPERATIVE AND NON-COOPERATIVE BEHAVIOR IN A TWO-PERSON GAME

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The Effect of N-length on the Development of Cooperative and Non-cooperative Behavior in a Two-person Game[1]

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This study was devoted to the investigation of a basic learning process associated with cooperative and non-cooperative behavior. The general approach used was that of game theory. The novelty introduced into this general approach involved the use of patterns of reinforcement, i.e., partial reinforcement, and number of nonreinforced trials which occur before a reinforced trial (N-length), as independent variables. Many current learning theorists, heavily influenced by the behavior theory tradition as represented by Clark L. Hull and Kenneth W. Spence, are contributing to an extensive literature on reinforcement variables, particularly, pattern of reinforcement.

The game theory model provides an excellent way of studying the dynamics of two-person social interaction. Gallo (1965) defines a game as "a situation in which the persons involved are attempting to attain some goals and in which their success or failure is dependent

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[1]The authors are indebted to Vada Benjamin of Texas Southern University who assisted in the conduct of the study.

not only upon their strategy choices but also upon the strategy choice of the other individual(s) in the situation" (Gallo, 1965, p. 68). Shubik (1964) and Rapoport (1959) go into greater detail on the use of game theory models.

Serious consideration has not been given to pattern of reinforcement in game theory studies, even though it has been found to be a crucial determiner of behavior in learning theory studies with lower organisms. A common finding in game theory studies is that subjects increase their non-cooperation and decrease their cooperation as a function of trials, regardless of personality, magnitude of reinforcement or manipulation of social variables (Manning, 1965). Since reinforcement pattern can act as a major stimulus (Logan, 1965), its influence in a game theory experiment could easily override other variables being manipulated if it were not taken into consideration. It is reasonable to assume then, that pattern of reward should be varied systematically within a game theory context if the learning of cooperative and non-cooperative behavior is to be understood.

Before the actual game theory model to be used in this study is considered, it will be necessary to discuss some of the reinforcement variable literature. Specifically, the reinforcement variable literature will be approached from a "sequential hypothesis of instrumental learning" (Capaldi, 1967) and will focus on the representative research that has led Capaldi to this sequential approach. In the first part of this discussion, the boundary conditions in the

research under consideration will be limited to the traditional instrumental learning situations, especially those of the straight alley runway using rats that have undergone a certain period of food deprivation and are subsequently given a set schedule of reinforcement. A typical dependent variable is the response speed of a rat running down a straight alley runway during the acquisition and extinction phases of the experiment.

The second part of the reinforcement variable literature reviewed here will be concerned with child studies dealing with both instrumental and discrimination learning. In these studies, the child usually has a chance to manipulate one or more parts of his immediate environment for a reward. The reward is usually a piece of candy or a trinket. Since there were no child studies found that used a "sequential hypothesis" approach, the studies included in this section will only be indirectly related to the major concerns of the present study. On the other hand, these studies represent examples of experimental work with children which would seem to offer situations in which the "sequential hypothesis" approach could be used. A third part of the review of reinforcement variable literature will be concerned with studies on the cooperative behavior of children.

Reinforcement Variables and Instrumental Learning with Animals

Partial reinforcement is a major variable studied in reinforcement variable literature. It is essentially a pattern of reinforcement

in which reinforcement is given only on a certain percentage of the total number of trials in an experiment. Jenkins and Stanley (1950), in a review of the partial reinforcement literature up to 1950, came to the following conclusion:

> All other things being equal, resistance to extinction after partial reinforcement is greater than after continuous reinforcement when behavior strength is measured in terms of single responses. (Jenkins and Stanley, 1950, p. 222)

A study which generated much subsequent research on patterns of reinforcement was published by Sheffield (1949). Sheffield ran one group of partially reinforced rats with massed trials (trials immediately following each other) and another group of partially reinforced rats with spaced trials (in this case, a 15 minute time lapse between trials). She found that the spaced partial group was more resistant to extinction than was the continuously reinforced group. To explain this result she turned to the intertrial interval.

The stimulus aftereffects of nonreinforcement were assumed to dissipate as a function of time for the spaced partial groups. Hence, the cues of nonreinforcement could not be conditioned to the locomotor response; whereas for the massed partial group these cues were conditioned to the locomotor response. If the rat is used to responding in the presence of nonreinforcement, this should aid responding in an extinction series.

Unfortunately, the research replicating the Sheffield study failed to support her results. However, the aftereffect notion remained a valuable contribution. Lewis (1960) explained that the

partial reinforcement effect holds, regardless of any spacing of trials. He explains away Sheffield's (1949) results in the following manner:

> Since her conclusion is based on a presumed interaction between percentage of reinforcement and acquisition interval, the analysis of variance was the appropriate statistical technique. Her analysis by means of the t-test was, however, suggestive of her conclusion. (Lewis, 1960, pp. 9-10)

The Sheffield experiment was important in that it prompted learning theorists to seriously consider the possibility that the stimulus complex which was the result of the aftereffects of reinforcement would be an important learning variable.

Capaldi and Senko (1962) trained rats on a 33% nonreinforcement schedule. The rats ran faster following nonreinforced trials and slower following reinforced trials. They were then switched to a single alternation schedule of reinforcement. At this point, immediate and consistant pattern running occurred. The animals learned to respond slowly on trials following reinforcement and rapidly on trials following nonreinforcement. Hence, there was transfer of learning from the 33% reinforcement schedule to the single alternating schedule. The reinforcement outcome of the previous trial then modified the stimulus complex.

Capaldi and Hart (1962) ran two experiments in which rats were trained under either continous, irregular, or single alternating reinforcement. The single-alternation group was more resistant to extinction than the irregular one. Capaldi and Hart stated that, in general

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the literature has shown that with moderate numbers of acquisition trials, alternating reinforcement and irregular reinforcement are about equally resistant to extinction. With large numbers of trials, the alternation group is less resistant to extinction than the irregularly reinforced group. With a small number of trials, the irregular group is less resistant to extinction than the single alternation group. The authors state that:

> It should be noted that current evidence indicated that the tendency of SA reinforcement to result in equal or greater resistance than R patterns occurs prior to the appearance of pattern running, i.e., relatively rapid running of reinforced trials, relatively slow running on nonreinforced ones. (Capaldi and Hart, 1962, p. 169)

It was also found in the Capaldi and Hart study (1962) that the number of transitions from nonreinforcement to reinforcement was positively related to resistance to extinction. The single alternation group would be the most resistant to extinction in this case, especially when the number of reinforcements, number of trials (small) were all equated. Capaldi and Wargo (1963) ran a similar study, but with an intertrial interval of 20 minutes, as compared with the Capaldi and Hart (1962) intertrial interval of 15 seconds. The results of both studies were identical. The single-alternating group was more resistant to extinction than the randomly reinforced group.

Capaldi and Spivey (1964) ran 10 rats in a straight alley runway on a single-alternation reinforcement schedule and a one-trial-per-day basis. There was a total of 126 trials. Even with an intertrial interval as long as 24 hours, pattern running developed. For

Capaldi and Spivey, this suggested that the stimulus consequences of reinforcement and nonreinforcement are more related to memory than to stimulus traces:

> A major implication of the present results is that a theoretical analysis based on S_G and S_{NG} need not be restricted to the massed trial situation, as has been suggested...but would appear to be applicable whatever the conditions of trial spacing. (Capaldi and Spivey, 1964, p. 404)

The S_G and S_{NG} above symbolized traces of reinforcement and nonreinforcement, respectively. What is being said here, then, is that the massed and spaced practice conditions used by Sheffield (1949) were not really relevant, but that the memory of the traces of reinforcement and nonreinforcement was.

Capaldi, Hart and Stanley (1963) state that probably the most direct test of the aftereffects hypothesis is to make it impossible for the aftereffects to become in any way conditioned to the instrumental locomotor response. The aftereffects of nonreinforcement are conditioned only on reinforced trials. A technique to be discussed here which alters the aftereffect of nonreinforcement and replaces it with the aftereffect of reinforcement is referred to as an intertrial reinforcement (ITR). ITR is essentially a reinforcement introduced between regularly scheduled trials of reinforcement and nonreinforcement. Of course ITR is most effective if the normal reinforcement situation is similar to the ITR situation. In a typical Capaldi experiment using ITR, the rat spends 15 seconds between trials in a neutral waiting box, followed by a 15 second period in a baited goal box in which it has been <u>placed</u> by the experimenter. Then, the rat

is placed in the start position at the beginning of the runway and the next trial begins. The placing of the rat in the baited goal box constitutes the ITR. That is, the rat leaves a neutral waiting box and is placed in the goal box and reinforced without any effort on its own. In the Capaldi, Hart, and Stanley (1963) experiment two groups of rats were given the same patterns of partial reinforcement. One group received ITR following nonreinforced trials, and preceding reinforced ones, and the other group received ITR following reinforced trials which preceded either reinforced or nonreinforced trials. The first partial group did not demonstrate the typical partial-reinforcement effect when compared to a continuously reinforced group; whereas the second partial-reinforcement group did.

Capaldi (1964) ran three experiments with the following results and interpretations. In the first and second experiments there were three groups of nine rats each. A straight alley runway was used, and the pattern of partial reinforcement was the same for all groups. The number of intertrial rewards was equated for all groups. As the number of nonreinforced trials following an intertrial reward and preceding a reinforced trial in the runway increased, so did the resistance to extinction.

In the third experiment, two irregular patterns of 50% partial reinforcement were used. There were also different numbers of acquisition trials. The first pattern of reinforcement consisted of a single N-length of three (three nonreinforcements, one after the other). The

second pattern of reinforcement contained three different N-lengths (one, two and three). The numbers of acquisition trials included small, moderate, and large numbers.

The group receiving a single N-length was more resistant to extinction than the varied N-length group for a small number of trials. The single N-length group was likewise equally resistant to extinction to the varied N-length group for a moderate number of trials. The single N-length group was less resistant to extinction, however, than the varied N-length group in the case of a large number of acquisition trials.

Capaldi concluded that stimulus aftereffects undergo modification as a function of successive nonreinforcements. For a large number of trials a group receiving different N-lengths will generally be more resistant to extinction. Capaldi (1964) explains this on the basis of the summation of habit strengths (in the Hullian sense). In his 1964 experiment reviewed above, all of the separate values of N-length had reached asymptotic habit strengths. Hence, there are three entirely different sources of habit strength. Accordingly, resistance to extinction in a partial reinforcement situation may be predicted on the basis of the length of a series of nonreinforcements. These nonreinforcements are assumed to be conditioned to the locomotor response. Also important are the frequency with which the particular value of N-length is presented, and finally, the number of different nonreinforced lengths conditioned to the locomotor response. Capaldi regards the

stimuli of the previous trial (Tp) as being "permanent" and considers that the stimulus complex on current trials will show wide variation as a function of the stimuli of the previous trial (Tp). Capaldi (1966), and Capaldi (1967) go into greater detail on the "sequential hypothesis of instrumental learning."

There has, however, been some problem with the use of ITR in N-length experiments. The problem has developed in the extended trial case. Both the Black and Spence (1965) and Spence, Platt, and Matsumoto (1965) studies failed to demonstrate the effectiveness of ITR in eliminating the partial reinforcement effect after extended training. It was not completely clear whether this failure was the result of a large number of reinforced trials, or the result of the repeated usage of ITR.

Capaldi and Oliver (1967) designed an experiment to answer this question. They gave three groups of rats 96 consistently reinforced trials. The second part of the experiment consisted of 30 more acquisition trials for all groups. One group (group PN) was given ITR's between nonreinforced and reinforced trials with a 50% partial reinforcement schedule. A second group (group PR) was given ITR's only after reinforced trials. A third and last group was given continuous reinforcement for all of the final 30 acquisition trials. In the extinction phase of the experiment, group PR demonstrated the usual partial-reinforcement effect, but groups PN, and C did not. Capaldi and Oliver successfully demonstrated that the reduced

effectiveness in ITR was not due to a large number of reinforced trials, but rather to the repeated usage of ITR itself. One explanation that was given for this characteristic of ITR in the Spence studies was that ITR failed to replace the aftereffects of nonreinforcement with reinforcement as the result of the subject's gradually learning to discriminate between ITR and rewarded trials.

Reinforcement Variables and Instrumental and Discrimination Learning with Children

Although schedules of reinforcement have been studied in learning tasks with children for a number of years and have shown partial-reinforcement groups to be more resistant to extinction than continuous-reinforcement (Grosslight and Child, 1947), (Fattu, Mech, and Auble, 1955), (Bijou, 1957), and (Parker, 1967), little attention has been given to the sequential pattern of reinforcement and nonreinforcement. There has been a recent concern with the effects of nonreinforcement upon learning in children (Ryan and Watson, 1968) but here, the theoretical focus has been on a frustration hypothesis approach (Amsel, 1958) rather than on a sequential hypothesis. Within the context of the frustration-hypothesis approach Ryan and Watson summarized a number of studies which showed increased performance as a result of partial reinforcement. The frustration hypothesis postulates, basically, that nonreinforcement introduces a strong frustrative drive and subsequently increases performance.

In a study by Evans and Endsley (1966) it was shown that as the ratio of reinforcement to nonreinforcement decreased, performance on a discrimination task increased. However, it is difficult to compare this type of investigation to the type of experiment that Capaldi has used. Even when one discounts, for the moment, the fact that the Evans and Endsley study was concerned with discrimination learning, there are many other differences typically found in child studies which make comparison with acquisition-phase extinction-phase animal studies difficult. In this investigation there was an alternating series of forced trials and free-choice trials. The forced trials contained both immediately reinforced and nonreinforced trials, and the free-choice trials were either all rewarded or all nonrewarded. Also, to complicate the problem of generalization, there was a delay-of-reinforcement variable introduced in the free-choice trials such that the subjects were not allowed to see the results of the trials until the reward for each block of free-choice trials had accumulated.

The importance of the Evans and Endsley study for the present study is that children have been shown to be responsive to the ratio of nonreward and reward, implying the possibility that these experiences produced definite aftereffects to which they respond. Their study also illustrates the importance of holding the number of reinforcements and nonreinforcements constant for all partially-reinforced groups if one wishes to explore the effects of the actual sequence of patterns of reinforcement without contaminating the results with a percentage of reinforcement effect.

Evans and Endsley cite Lachman's (1961) suggestion that the r_f-s_f mechanism (frustrative nonreward) associated with the goal response produces a steeper acquisition gradient than r_g-s_g (developed from reinforcement) and provides an additional theoretical basis for keeping the ratio of nonreinforcement and reinforcement constant.

Other child studies that have shown partial reinforcement to produce superior performance to 100% reinforcement, as measured by speed of lever pulling, are Semler and Pederson (1968), Pederson (1967), and Watson and Ryan (1966). These three studies all explained their results in terms of the frustration hypothesis.

Ryan and Voorhoeve (1966) ran a child study which was more directly analogous to the usual rat study found in the partial-reinforcement literature. They ran the following percentage-of-reinforcement groups: 100%, 70%, 50%, 30%, 10%, and 0%. They used speed of lever movement as their dependent variable. Ryan and Voorhoeve pointed out that child studies using as a dependent variable the number of responses per unit time have obtained the partial-reinforcement effect, but that the (PRE) has not been demonstrated with the speed of lever pulling. They then cited Bruning's (1964) finding that children reinforced 50% of the time responded faster in a lever movement task than did a 100% group during acquisition but both groups increased their speed during a 12-trial extinction phase.

Even though Ryan and Voorhoeve used 30 extinction trials in their study, the results were still confusing. The 30% reinforcement

group increased its speed, the 70% group decreased, and the 100%, 50%, and 10% reinforcement groups demonstrated no change. It was pointed out at this time that with S's instructed at first to pull the one lever every time a stimulus light is presented, extinction may not occur. In a game theory experiment where there are two levers (cooperation and non-cooperation) this problem would not occur, since constant pulling of a non-cooperation lever is operationally defined as an extinction of a cooperative response. Ryan and Voorhoeve also pointed out that having the rewards from acquisition present in extinction could also have retarded extinction. Capaldi (1967), in discussing similar experiments using rats, has also commented on the importance of not having accumulated rewards present, since it most likely alters the stimulus complex present on any given trial.

It should be taken into consideration that speed of response in lever pulling may not be as clear an index of learning as responding or not responding or as pulling one lever which means one thing to the subject versus another lever which means something else. For example, a lever could be pulled faster in anger from frustration or slower in disgust from frustration, depending on the subjects' previous learning experiences. Although this may be said of any such simple response (pulling or not pulling or speed of pulling), it is conjectured here that speed of response in lever pulling might be a less stable response and might be more distorted by momentary fluctuations of emotions in children. The fact that a consistent PRE has not yet

been demonstrated with this type of learning index partially supports this conjecture. Also, Watson and Ryan (1966) investigated the duration of frustration-drive increase due to nonreinforcement in children. The subjects performed two sequential lever pulling responses (R1 and R2). R1 was reinforced on a partial basis and R2 was always rewarded. Reward was given after either 5, 10, or 20 seconds on R1. It was found that nonreinforcement produced an increase in response speed only when reinforcement was given at five-second intervals and had dissipated by the time the duration was as long as 10 seconds. It seems that if nonreinforcement arouses frustration and an increased motivational state that is measurable only when the subjects are rewarded at five second intervals (when rewarded), then a speed of lever-pulling response would be a most sensitive index to this momentary emotional state--a sensitivity which may add more confusion than necessary when one is attempting to study basic learning processes.

Penny (1960) has taken essentially the same non-motivational and associative approach to the study of the effects of nonreinforcement with children as has Capaldi with rats. Penny found that the number of continuously reinforced trials previously given was the most important factor in the development of an increase in performance when groups of children were switched to nonreinforced trials. The frustration hypothesis can not explain this result since frustration and subsequent increased performance is assumed to be the result of nonreinforcement alone. The groups which received fewer reinforced trials did not show any nonreinforcement effect.

Lester (1966b) ran a three-trial partial reinforcement study concerned with the effects of limited trials on the partial-reinforcement effect. Although he was not able to replicate McCain, Reed, and McCormack's (1963) finding using the same number of trials, the same type of population (children), and the same basic experimental task, his experiment is relevant to the present study in that he varied the pattern of reward. Lester did not refer to any of the work done with stimulus aftereffects or pattern of reward, but he did give the following reward schedules which can be described in terms of N-length: RNR (N-length of one); NNR (N-length of two); and a continuously reinforced group RRR. It is interesting to note that the N_2-length group (NNR) was the most resistant to extinction on the first five extinction trials, even though the groups did not differ on the remaining extinction trials (trials 6-10), or on all extinction trials considered together. Since Capaldi and Deutsch (1967) were able to show the PRE with five acquisition trials using rats, the failure of Lester (1966b) to get the usual PRE may be due to a combination of greater control using rats (for example Capaldi and Deutsch's subjects underwent a 19-day food deprivation schedule of 12g day) and the fact that the rats received two conditionings of N_1-length while Lester's children received only one conditioning of N_1-length or N_2-length.

Lester found in a later study (1967) that it was the subject's expectations of reward rather than the actual pattern of reward which determined resistance to extinction. If the development of expectations does play a role, it would seem reasonable to assume that it would be

most important in a three-trial case where the subject has little information from which to judge. Perhaps it is a little too much to anticipate that the expectations of grade school children be immediately modified after only three acquisition trials. In support of this assertion, Parker and Nunnally (1966) found in an experiment with children that the amount of expectancy of reinforcement was an increasing monotonic function of the percentage of reinforcement. In other words, the more frequently children were reinforced, the greater their expectations would be of receiving a reward.

Lester (1966a) also pointed out that age is an important factor in this type of conditioning (where a subject said "yes" or "no" to the experimenter) and found that children under the age of four years generally say "yes" in guessing whether or not a reinforcement is in a box, regardless of the contents of this box on previous trials.

Viney, Hulicka, Bitner, Raley, and Brewster (1968) ran a study concerned with the general stimulus context in acquisition and extinction phases of the experiment. Sixty children were used in this study--all of whom were of kindergarten age. The children were given a two-choice discrimination task. Following each correct response there were five specifiable stimuli. After the acquisition phase of the experiment there were six different extinction conditions. These conditions were all varied on the basis of the number of stimuli present during the acquisition phase. Resistance to extinction varied positively

with the commonality of the stimuli in acquisition and extinction conditions of the experiment. It is interesting to note that Hulicka, Capehart, and Viney (1960) found the same general results that Viney et al. (1968) did using the same general experimental design, but with rats as subjects.

Cooperative Behavior in Children

There have also been a few operant-conditioning studies of the development of cooperative behavior in children. One such study was done by Azrin (1956). It was concerned with whether cooperative behavior between children could be developed, maintained and eliminated as a function of the presentation or non-presentation of a single reinforcer which was available to each member of a two person team after they had both made a cooperative response. Each pair (team) of children made a cooperative response when they placed their styli in directly opposite holes from each other (each subject had three holes from which to choose) and were subsequently rewarded. There were three phases of the experiment: 1) acquisition phase; 2) extinction phase; and 3) reacquisition phase. Cooperative behavior was developed during the first acquisition phase, became more variable during the extinction phase, and was reestablished during the reacquisition phase. This experiment had the advantage of eliminating instruction effects upon the subjects and limiting the main stimuli to those of reinforcement and nonreinforcement. [This same general finding was made by Loh (1966).]

Brotsky, and Thomas (1967) also ran a study in which children were reinforced for cooperative behavior, defined as simultaneous responses, within an operant-conditioning situation. Even though a significant increase in cooperative behavior occurred during the 10-minute acquisition period, there was likewise an increase in non-cooperative behavior. Brotsky and Thomas concluded that the children were really learning the operant response of pressing the knobs, rather than learning an actual form of cooperative behavior. It seems that the children should perhaps be told, in some way, the meaning of the alternative choices that they have in an experiment which is investigating cooperative behavior.

A less artificial, but unfortunately also less well controlled study of cooperative behavior in children was made by Brown and Elliott (1965). They investigated the incidence of aggression of a nursery school class and attempted to modify aggression by rewarding cooperative behavior and ignoring aggressive behavior. They were able to successfully reduce verbal aggressive behavior for a period of several weeks, but physical aggression occurred again after the conditions of reinforcement were removed.

Manning, Pierce-Jones, and Parelman (1968) ran a study of the cooperative behavior of children using operant-conditioning techniques and attempting to make it possible for the children to have some understanding of what their responses meant. This study used a game-theory approach and the children were told the immediate consequences

of each of their two alternative responses. These alternatives were: 1) if one lever were pulled they would receive candy themselves and also give candy to the child with whom they were playing a "game"; or 2) if the other lever were pulled they would receive a piece of candy for themselves but not give the other child any candy. The experimenter controlled the reinforcement, giving 50% constantly and making the other 50% contingent upon each child's cooperation on the previous trial.

Although cooperative behavior did not develop as a function of trials, significant differences were found in the amount of cooperative behavior for females playing members of different ethnic groups ($p < .05$, low levels of cooperation for dissimilar pairs) and for females of different ethnic groups ($p < .01$, with white Anglo-Americans competing the most).

A Game Model and Reinforcement Variables

The problem in making a game theory analog of an instrumental-conditioning model lies first in the fact that the instrumental model requires that the focus will be on only one type of response (such as pulling one lever), which is reinforced or nonreinforced depending on the particular experimental design. A game theory model presents a choice situation and hence defines the learning situation as a selective-learning task. In commonly used models of game theory there are at least two basic responses to be made, i.e., cooperation and

non-cooperation. That is, there are two levers, either of which may be pulled by the subject. Capaldi (1967) has pointed out that his theoretical findings have only been applied to the instrumental situation. He also stated that it is not yet known whether sequential theorizing will be relevant to selective learning situations, although attempts should be made to deal with more complex learning phenomena than instrumental learning with this type of theorizing.

One way to build such a game theory analog which takes into consideration the selective-learning nature of that model and allows for sequential theorizing would be to give constant nonreinforcement to one lever (to the non-cooperation lever if one is interested in developing cooperative behavior) and to vary reinforcement and nonreinforcement on the other lever (in this case the cooperation lever). Such a procedure presents several obvious difficulties in establishing a direct relation between the events of the instrumental situation and the selective-learning situation. By constant nonreinforcement of the non-cooperative response there is, at the very least, a delay in giving a set reinforcement schedule (i.e., varying N-length) for the cooperative response. There is then the problem of a varying total number of acquisition trials for all subjects, even though a set unvarying number of trials would occur on the cooperative lever. As a result of these conditions, the length of the acquisition phase would be dependent upon the number of times the subject decided to pull the non-cooperation lever even though no reward resulted. However, since

the concern here is with the development of cooperative behavior, it seems that the equalization of the number of times the cooperation lever is pulled in the acquisition series for all subjects provides sufficient uniformity of experience for the subjects.

The game that was used in this experiment, had to meet a number of specific requirements. First, there had to be a two-choice situation--one choice involving a decision to cooperate, and the other representing a decision of non-cooperation. Second, the game would have to be designed in such a manner that reinforcement would never be given for a non-cooperative response but would be given on a 50% schedule (with the exception of a continuously-reinforced control group) for a cooperative response. Third, the game had to allow for periods of intertrial reinforcement. Fourth, the game would have to be designed in such a manner that each subject would feel that he had equal power over the other subject's (the subject with whom he was playing the game) incentive gain. The details of this game are described in the method section of this study.

Patterson and Hinsey (1964) have pointed out that the "meaning" that the experimental situation has to the child is quite important. Accordingly, the question then arises as to what the children were expected to perceive in the present study in which they had a choice of giving or not giving a piece of candy to a game partner. It was conjectured that the child involved in a study of this type would grasp the fact that he had the power to give the child with whom he

was playing a reward or not give him a reward, and that the other child had the same power over him. The child could at first rationally expect that, if he gave the other child a piece of candy, this candy-giving would be reciprocated. On the other hand, due to the fact that the reinforcement schedule was predetermined at a 50% level for the cooperative choice, the children would learn that they would receive a reward from their game partner on only some of the trials and not necessarily immediately after they had given their partner candy--a situation that is, perhaps, closely related to common experience.

Hence, a cooperative response (giving one's partner candy) was being conditioned on a partially-reinforced basis. In the extinction phase of this study the concern was with the extent to which cooperative behavior (candy-giving response) would persist when it appeared to the child that his partner had stopped giving candy altogether. If the resistance to extinction is increased as a function of N-length, it would be expected that children from the population used in this study learn to cooperate best under conditions of extended periods of negative (non-cooperative) feedback from the environment with only periodic reinforcement for their cooperative efforts. Much of "common experience" seems to suggest that the type of feedback given in this study (50% reinforcement with varying periods of negative reinforcement for cooperative efforts) is within the limits of normal expectation in many types of unilateral cooperative efforts. By varying N-length in this study it was hoped that it would be possible to specify certain

antecedent events in the subject's immediate environment (stimulus aftereffects of reinforcement and nonreinforcement) and from these events predict consequent results. On the basis of the literature discussed up to this point in this study, in particular on Capaldi's "sequential hypothesis of instrumental learning," the following hypotheses were made.

Hypotheses

Hypothesis I: Subjects given an N-length of three for cooperative responses during acquisition will be the most resistant to extinction.

Hypothesis II: Subjects given an N-length of two for cooperative responses during acquisition will be less resistant to extinction than subjects given an N-length of three and more resistant to extinction than subjects given an N-length of one or continuous reinforcement.

Hypothesis III: Subjects given an N-length of one for cooperative responses during acquisition will be less resistant to extinction than subjects given an N-length of three or two and more resistant than subjects given continuous reinforcement.

Hypothesis IV: Subjects given continuous reinforcement for cooperative responses during acquisition will be the least resistant to extinction.

Method

Subjects

The subjects consisted of 80 Negro four and one-half, five and six year old males from a culturally deprived population from the Houston Texas Day Care Centers. These subjects were divided into four equal groups of 20 each. Three of the groups were each given a different N-length in the acquisition phase of the experiment, while the fourth group was given continuous reinforcement.

Experimental Groups

As indicated above, the treatment effect used was the variation of N-length defined as:

> ...the number of nonreinforced (N) trials which occur in succession without interruption by a reinforced (R) trial. (Capaldi, 1964, p. 230)

There were four groups which were given the following treatments in the acquisition phase of the experiment: 1) Group I received an N-length of one; 2) Group II received an N-length of two; 3) Group III received an N-length of three; and 4) Group IV received continuous reinforcement.

Game Model

The game used in this study was the type of game referred to by Wilson and Bixenstine (1962) as "absolute control over other's gain." In this type of game each player has control over the other player's gains but not over his own personal gains. If both players choose to make cooperative responses, they will maximize their incentive gain,

but will minimize their gain if they make non-cooperative responses. The game matrix that was used has the same basic relationships as has the one illustrated by Wilson and Bixenstine, but the absolute values are changed. The game matrix that was used in the present study is presented below:

		Column A	Column B
Row	A	1,1	0,1
	B	1,0	0,0

In the above matrix, if the row player chooses an (A) (cooperative) strategy and the column player chooses an (A) strategy, each will receive an incentive gain of one. If the row player chooses a (B) (non-cooperative) strategy and the column player chooses an (A) strategy, the row player will receive an incentive gain of one and the column player will receive an incentive gain of zero. If the row player chooses an (A) strategy and the column player chooses a (B) strategy, the row player will receive an incentive gain of zero and the column player will receive an incentive gain of one. If both row and column players choose a strategy of (B), they will both receive an incentive gain of zero.

The set of relationships described above, though essentially quite simple, would be far too complex for the sample used in this study to grasp. The subjects used in this study were instead told

that they had two choices. The subjects were told that they could pull one lever marked with an (X) and give their game partner a piece of candy or they could pull an unmarked lever and not give their partner any candy. These choices were respectively designated as cooperative or non-cooperative. After both subjects had made their choices on any one trial they each received any one of the four possible combinations of scores. (In studies using adults, the subjects' choices are usually made simultaneously.) Of course, the actual outcome of any one trial was dependent upon the predetermined reinforcement schedule which will be described in the next section.

Reinforcement Schedule

Fifty percent partial reinforcement was given to Groups I, II, and III for the first 30 responses made on the cooperative lever of the game board. After this point in the experiment each subject was switched individually to the extinction phase of the experiment (whenever they had made a cooperative response 30 times). The subjects were all given at least 30 extinction trials in which reinforcement was completely terminated for the cooperative response. The non-cooperative lever pulling was never reinforced, neither in acquisition or extinction. The continuously-reinforced group (Group IV) received 100% reinforcement for the first 30 responses made on the cooperative lever, followed by termination of reinforcement in the extinction phase.

All four groups received five intertrial reinforcements (ITR) during the first 30 responses on the cooperation lever. Groups I, II,

and III received an equal number of reinforcements and nonreinforcements for the first 30 cooperative responses made. The actual reward schedule given for cooperative responses appears below:

Group I:	R N N X N R R R R N N X N R R N N X N R R R R N N X N R R N N X N R R
Group II:	R N X N N R R R R N X N N R R N X N N R R R R N X N N R R N X N N R R
Group III:	R X N N N R R R X R N N N R R X N N N R R R X R N N N R R X N N N R R
Group IV:	R X R R R R R R X R R R R R R X R R R R R R X R R R R R R X R R R R R

Symbols: R = reinforcement; N = nonreinforcement; X = intertrial reinforcement

Procedure

All subjects were run in pairs for two experimental sessions. In order to avoid fatiguing the children, an experimental session was not continued for more than an hour. The acquisition phase ranged from 45 minutes to an hour and the extinction phase was approximately 30 minutes in duration. The period of time between the acquisition and extinction phases was never greater than an hour. For subjects who cooperated early in the first session, but had a partner who did not, an extended period of extinction trials was used. This extended period of extinction was necessary in order to keep the game going. However, only the first 30 extinction trials for each subject were used in the data analysis.

After the subjects had been brought into the experimental room, they were seated side by side in front of one of the two game boards (described in the apparatus section). A Negro female experimenter

explained to them that they were going to take part in a game with each other in which they would have a chance to get some candy. The experimenter then proceeded to explain the game to the subjects. In brief, they were told that they would be given two choices on each of a number of turns that they would be taking throughout the game. One subject would have to wait while the other subject took his turn. The two choices were: 1) the subject could decide to pull a lever which would give the other subject a piece of candy (cooperative behavior), or 2) the subject could decide to pull another lever which would not give the other subject any candy (non-cooperative behavior). It was made clear to the children that they could keep the other subject from getting any candy, but that he might do the same thing to them. It was also made clear to the subjects that they were not to be allowed to talk or ask questions once the game had started. The subjects were then questioned in detail to make sure that they understood the game and the restriction of not talking during the game.

The total number of trials in the acquisition phase of the experiment was dependent upon the number of trials it took each subject to make 30 cooperative responses before he could be switched to the extinction phase of the experiment, which was a minimum of 30 trials. Since a second experimenter controlled the entire reinforcement schedule, the information received by the subjects about each other's choices was controlled as well.

In order to ensure that the children understood the game, the difference between their two choices, and the meaning of their choices, the female experimenter spent at least one-third of the experimental time coaching subjects. The actual coaching of the subjects included both verbal instruction and four practice trials. During the practice trials the subjects were allowed to inspect each other's reward trays in order to reassure themselves that the game boards actually worked. Throughout the experimental sessions the first experimenter commented to each subject separately, on the outcome of the other subject's choice; i.e., "he gave you a piece of candy, didn't he?"

Apparatus

The subjects were run with a portable apparatus developed and used in the Manning, Pierce-Jones, and Parelman (1968) study. The apparatus consisted of two subject game boards and two experimenter miniboxes. The subjects were seated at opposite ends of a table, one on each side of the experimenters, and separated from them by partitions. The two experimenters sat across the table from each other. One experimenter called out the subjects' names when it was their turn and recorded their responses. The other experimenter administered the rewards. Each subject's game board contained two levers which, when pulled, both activated a bell (in order to make the experiment more realistic and communicate to the subject that he had done something to the environment by pulling the lever) and turned on a light on the experimenter's panel, informing the experimenter of the subject's choice. The levers

on the subjects' panels represented the two choices possible in the game. The experimenter's miniboxes (one for each subject) each contained two lights which informed the experimenter of any one subject's choice for a given trial.

The panels that separated the two subjects from the experimenter each contained a small hole so that the experimenter could quietly slip the reward to each subject through an inclined aluminum tube. Recorded music was used as a masking noise to drown out the noise of the reward being given and to avoid having the subjects suspect that the other subject was being rewarded at any time other than when his "partner" in the game chose to cooperate with him.

M&M candies were used for reinforcement and were administered through inclined aluminum tubes into padded aluminum trays in order to decrease the noise of the reward administration. Intertrial reward was administered by announcing to the subjects that they were going to take a "quick rest period" and not to pull the levers until called again. The subject who was due for intertrial reward was then told that he could have a "free" piece of candy during this "quick rest period" and the intertrial reinforcement was placed in the reward tube and administered in the usual way. The difference, of course, between an intertrial reinforcement (ITR) and a regular reinforcement was that the subject made no effort to receive the ITR but did make an effort (pulling a lever) when receiving a regular reinforcement. After

a child received a piece of candy he was asked to place it in a "bank-like" box so that he would not be able to see the accumulated reward as the experiment progressed.

Results

Acquisition

The dependent variable used in this study was the number of cooperative responses made by each subject. The first data analysis made was a 4 X 6 analysis of variance with both between and within dimensions. The between dimensions were the four levels of N-length grouping. The within dimensions were six blocks of five trials, which were the last 30 responses made in the acquisition phase of the experiment. As can be seen from Table 1, the difference between groups was significant beyond the .001 probability level. It can then be concluded that N-length was a real source of variation in the acquisition phase. Hence, the groups were already cooperating at different levels before the onset of the extinction phase. As Table 1A indicates, the group mean scores were ordered as follows: 1) N_1-length (4.92); 2) 100% reinforcement (4.84); 3) N_2-length (4.69); and 4) N_3-length (4.12).

However, the difference within groups between blocks of five trials for all groups combined did not reach an appropriate level of significance. Thus, it may be concluded that there was no significant change in rate of cooperation during acquisition for all groups considered simultaneously. Likewise, there was no significant interaction

TABLE 1

Analysis of Variance on the Acquisition Trials

Source	df	MS	F
Between	79	2.97	
N-length Groups (A)	3	15.75	6.40***
Within	400	.40	
Trials (B)	5	.50	1.25
A X B	15	.37	.92

*** $p < .001$

TABLE 1A

Mean Number of Cooperative Responses

According to N-length Group and Blocks of Trials

	A_1(N_1-length)	A_2(N_2-length)	A_3(N_3-length)	A_4(100% Reinf.)
Groups	4.92	4.69	4.12	4.84

	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Trials	4.58	4.56	4.60	4.64	4.75	4.73
Groups by Trials						
A_1	4.95	[illegible]	4.85	4.90	5.00	5.00
A_2	4.75	4.75	4.65	4.60	4.80	4.60
A_3	3.85	3.85	4.00	4.30	4.30	4.40
A_4	4.75	4.85	4.90	4.75	4.90	4.90

effect between groups and trials. However, as can be seen from the graphing of groups by trials in Figure 1, the group given an N-length of three appeared to be cooperating at a lower level than the rest of the groups.

Extinction

The second data analysis made was also a 4 X 6 analysis of variance with both between and within dimensions. The between dimensions were the four levels of N-length grouping. The within dimensions were six blocks of five trials, which were the first 30 trials in the extinction phase of the experiment. As can be seen from Table 2 the difference between groups was significant beyond the .05 probability level. As Table 2A indicates, the group mean scores were ordered as follows: 1) N_1-length (4.86); 2) N_2-length (4.11); 3) N_3-length (4.07); and 4) 100% reinforcement (3.76). It can therefore be concluded that N-length was a real source of variation in the extinction phase. The ordering of the group means directly supports only the fourth hypothesis of this study, which was that the subjects given continuous or 100% reinforcement during acquisition would be the least resistant to extinction. The group receiving an N-length of one in acquisition was the most resistant to extinction followed by the groups receiving N-lengths of two and three which had almost identical means.

The within group differences between blocks of five trials for all groups combined was significant beyond the .001 probability level.

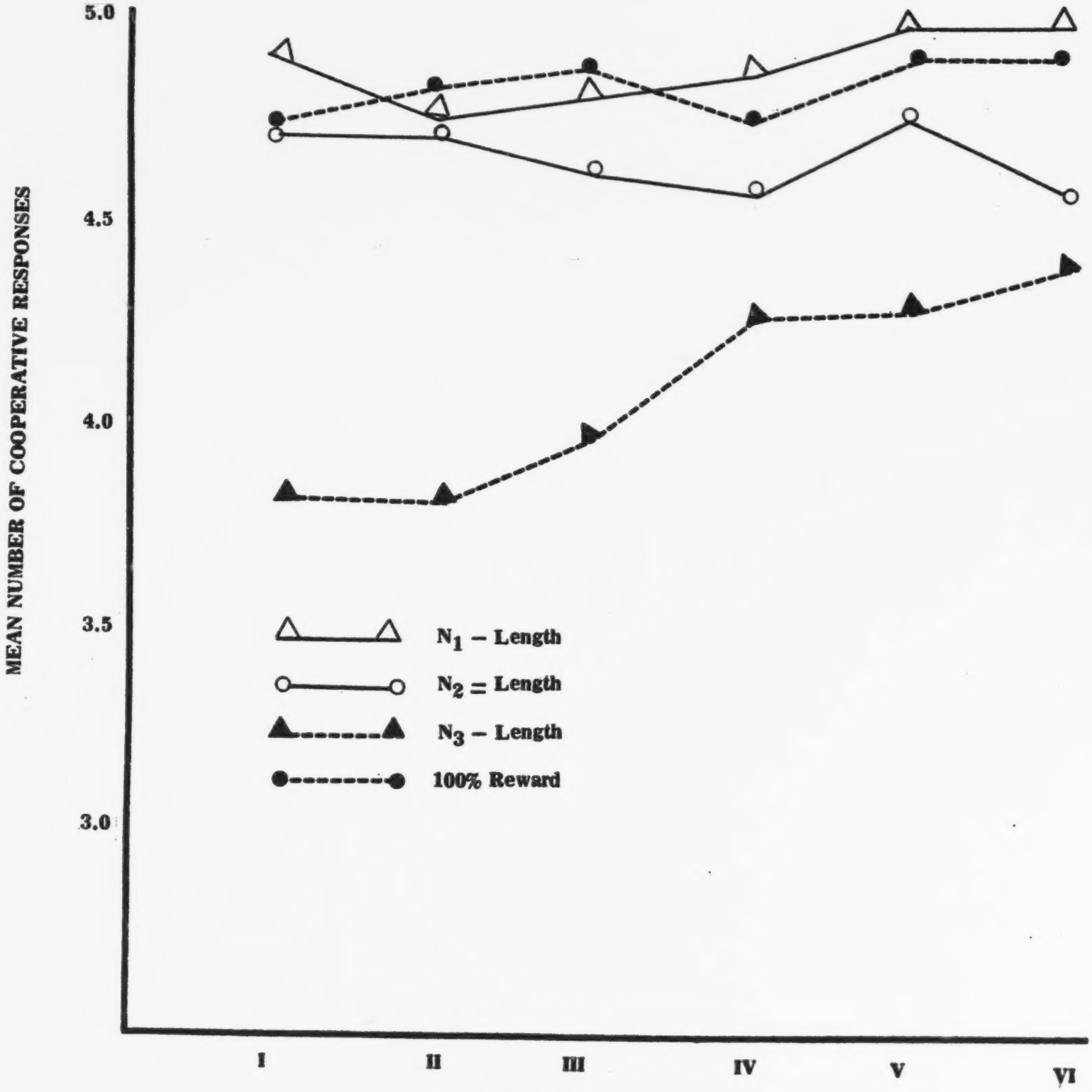

Fig. 1. Mean number of cooperative responses for each of the groups on each of the six blocks of acquisition trials.

TABLE 2

Analysis of Variance on the Extinction Trials

Source	df	MS	F
Between	79	9.81	
N-length Groups (A)	3	26.63	2.91*
Within	400	.64	
Trials (B)	5	4.18	7.21***
A X B	15	1.12	1.93**

* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 2A

Mean Number of Cooperatuve Responses

According to N-length Group and Blocks of Trials

	A_1(N_1-length)	A_2(N_2-length)	A_3(N_3-length)	A_4(100% Reinf.)
Groups	4.87	4.11	4.07	3.76

	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
Trials	4.60	4.34	4.00	4.14	4.05	4.08
Groups by Trials						
A_1	4.90	4.85	4.55	5.00	5.00	4.90
A_2	4.60	4.45	3.80	4.10	3.70	4.00
A_3	4.40	4.00	4.10	4.10	3.95	3.85
A_4	4.50	4.05	3.55	3.35	3.55	3.55

The trial means were ordered as follows: 1) 4.60 (first block); 2) 4.34 (second block); 3) 4.00 (third block); 4) 4.14 (fourth block); 5) 4.05 (fifth block); and 6) 4.08 (sixth block). As can be seen, the mean level of cooperative responses generally decreased as a function of trials which is what one would normally expect in an extinction phase of an experiment.

There was also a significant ($p < .01$) interaction effect for groups by trials. As may be seen from Figure 2, the group given an N-length of one decreased in its rate of cooperative responses through the third block of extinction trials. By the fourth block this group had returned to a slightly higher rate of cooperative responding than at the first block of trials and it maintained this rate with only a slight drop at the sixth block of trials. In contrast, the 100% reward group steadily declined (more than any of the other groups) in its rate of cooperative responding through the fourth block of trials. This decline was followed, during the fifth block of trials, by a slight increase in rate which was maintained during the sixth block of trials. The N_2-length and N_3-length groups were closest to each other in comparison with the rest of the groups. However, the N_2-length group changed its rate of cooperative responding more abruptly from one block of trials to the next than did group N_3-length.

Response Change from Acquisition to Extinction

The third data analysis made was a 4 X 2 analysis of variance with both between and within dimensions. The between dimensions were

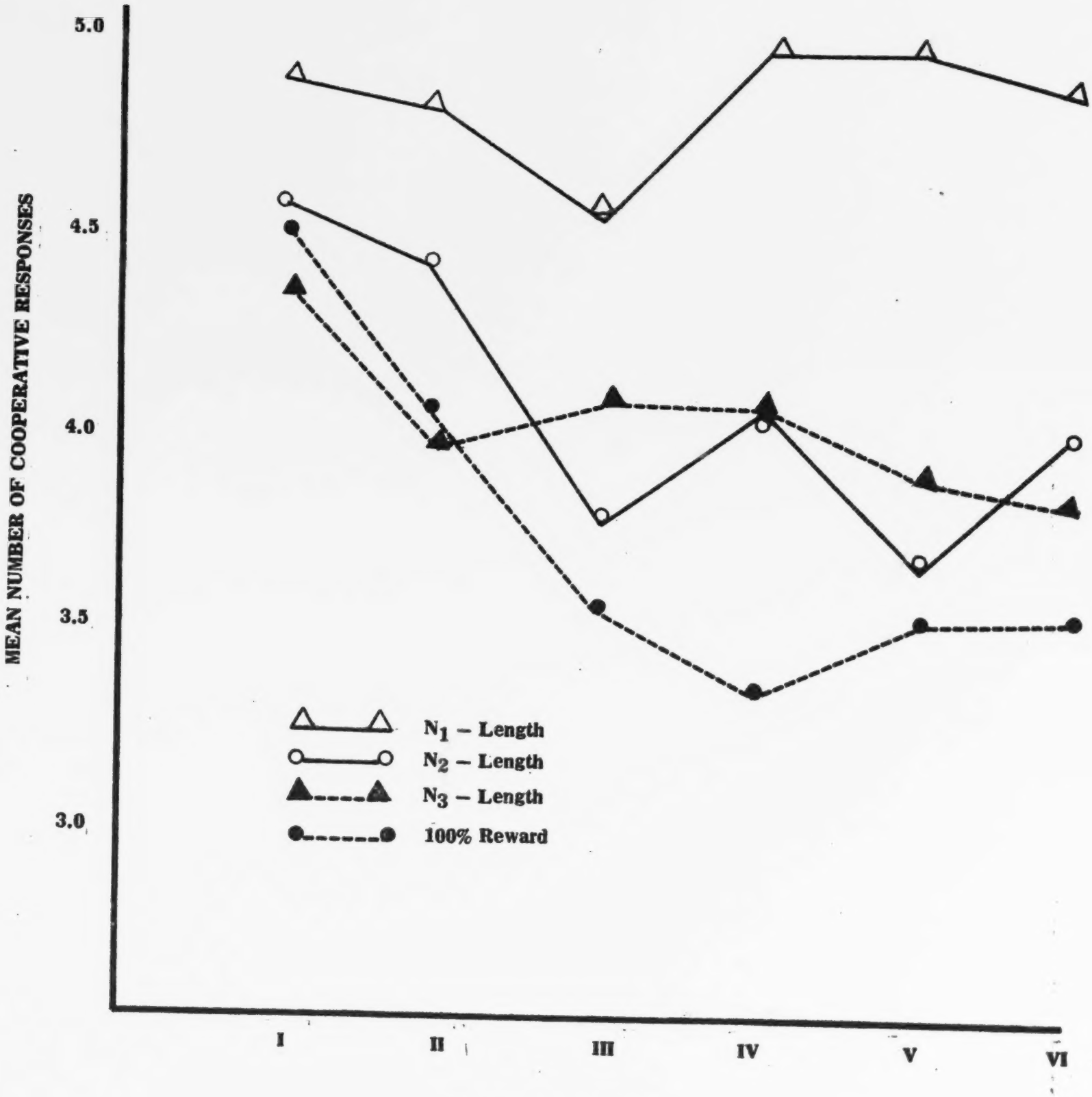

Fig. 2. Mean number of cooperative responses for each of the groups on each of the six blocks of extinction trials.

the same as the first two analyses with four levels of N-length grouping. The within dimensions were the combined blocks of trials for acquisition and the combined blocks of trials for extinction. This analysis was made in order to see which groups significantly changed in their rate of cooperation from acquisition to extinction. Table 3 indicates that the difference between groups was significant at the .05 probability level. It can be concluded that N-length was a real source of variation in the acquisition and extinction phases considered jointly. Table 2A indicates that the group mean scores were ordered as follows: 1) N_1-length (29.35); (2) N_2-length (26.40); 3) 100% reinforcement (25.80); and 4) N_3-length (24.55).

The within groups difference between total performance on acquisition and extinction for all groups combined was significant beyond the .001 probability level. The mean number of cooperative responses was 27.85 for the acquisition phase and 25.80 for the extinction phase.

The interaction effect for groups by trials (acquisition and extinction) was significant beyond the .01 probability level. As Figure 3 indicates, the N_1-length group and the N_3-length group changed only slightly in their overall rate of cooperation from acquisition to extinction. In contrast, the 100% reward group changed from a mean number of cooperative responses of 29.05 in acquisition to a mean of 22.55 in extinction. The N_2-length group changed from a mean of 28.15 in acquisition to a mean of 24.65 in extinction.

TABLE 3

Analysis of Variance on the

Acquisition and Extinction Trials

Source	df	MS	F
Between	79	56.49	
N-length Groups (A)	3	165.63	3.17*
Within	80	23.44	
Trials (B)	1	280.90	16.07***
A X B	3	88.63	5.07**

* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 3A

Mean Number of Cooperative Responses According to

N-length Group and Acquisition and Extinction Performance

	A_1(N_1-length)	A_2(N_2-length)	A_3(N_3-length)	A_4(100% Reinf.)
Groups	29.35	26.40	24.55	25.80
	Acquisition		Extinction	
Trials	27.85		25.20	
Groups by Trials				
A_1	29.50		29.20	
A_2	28.15		24.65	
A_3	24.70		24.40	
A_4	29.05		22.55	

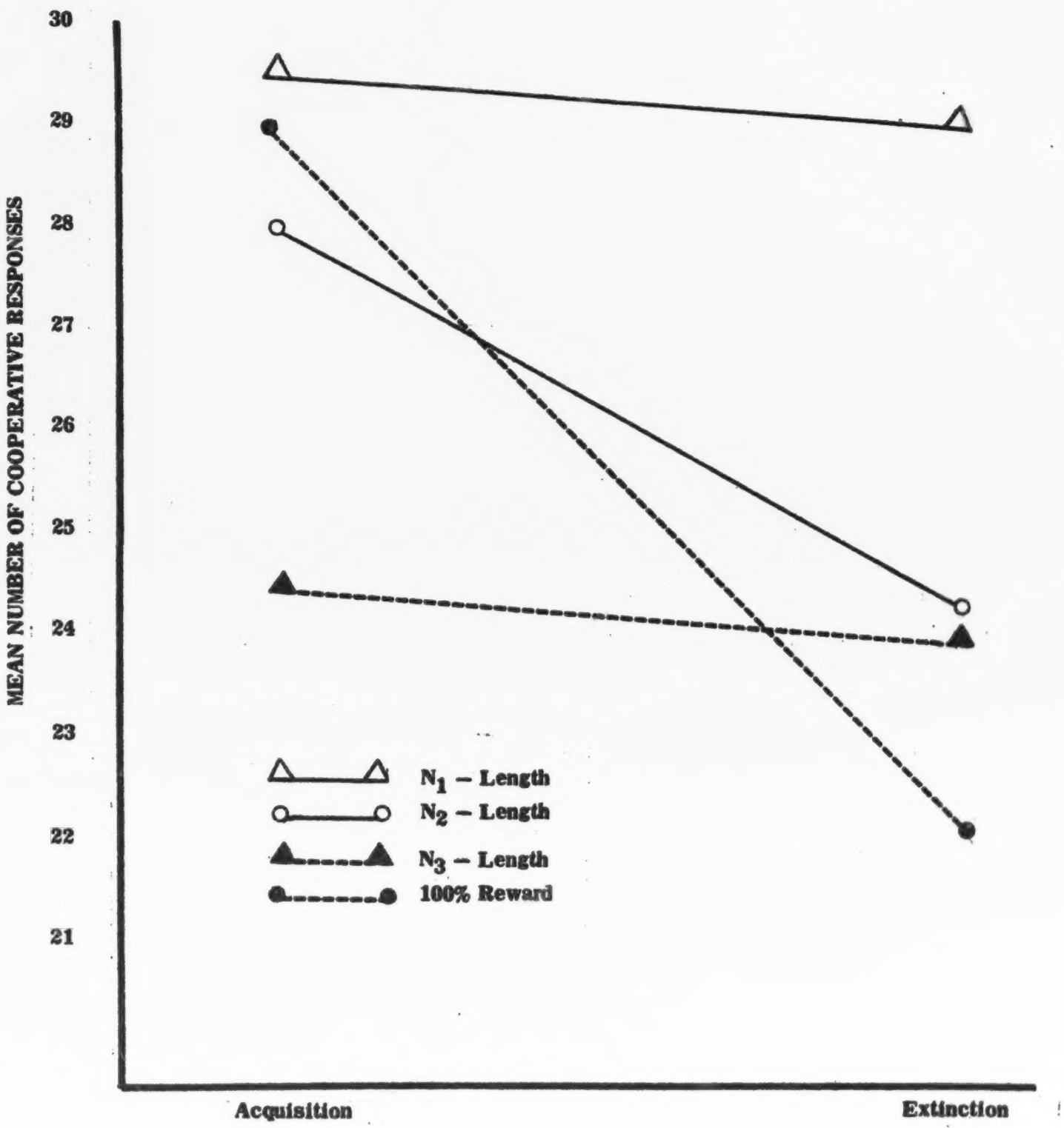

Fig. 3. Mean number of cooperative responses for each of the groups on the total acquisition and extinction trials.

Discussion

In general what the results of this study have shown is not only that the partial reinforcement effect can be demonstrated in a selective social learning situation (the 100% reinforcement group was the least resistant to extinction), but also that N-length affects the learning of a social response. Although the N-length groups did not order themselves in the predicted direction, it has still been demonstrated here that the number of nonreinforced trials between rewarded trials, when percentage of reward is held constant (50%), affects the degree to which a cooperative response is learned.

It is of course not at all surprising that relationships found with one type of behavior in a particular set of boundary conditions with a given species of organisms do not parallel relationships concerning different types of behavior, boundary conditions and species. On the other hand it is surprising to find a variable such as N-length to affect behavior in both an instrumental learning situation using rats and selective social learning situation using children.

Specifically, it was found that the N_2-length and N_3-length groups made fewer cooperative responses in both acquisition and extinction than did the N_1-length group. The N_1-length group held its high rate of cooperative responding in the extinction phase while the N_2-length group dropped. The N_3-length group cooperated less than the N_1-length and N_2-length groups in both acquisition and extinction. The 100% reinforcement group was almost identical to the N_1-length group in the acquisition phase, but cooperated the least of all four groups

in the extinction phase. A stimulus aftereffects hypothesis would predict the opposite results of the N-length findings in this study, but would accurately predict the finding in this study of the 100% group being the least resistant to extinction.

It should be kept in mind that the N_1-length group developed and maintained a significantly higher rate of cooperative response than the N_2-length and N_3-length groups, even though the percentage of reward for all three groups was a constant 50%. It appears from these results that an N-length beyond one given in a selective social learning situation with this particular population, results in a form of response inhibition for the social cooperative response which was being conditioned. It seems reasonable to assume that the children are thinking about the fact that they have been giving candy to the child across the room for three times in a row and the other child has not reciprocated. If such is the case, an N-length of one would build up response strength in the presence of the stimulus aftereffects of nonreinforcement and would maintain response strength in extinction. On the other hand, N-lengths of two and three would add a dimension of inhibition resulting from the subject's realization that his cooperative efforts were not being reciprocated.

One of the aspects of this study which was surprising was the high level of cooperative responding. Indeed, there were a number of subjects in all groups who cooperated almost every time in both the acquisition and extinction phase. This high level of cooperation in

one sense is amazing when it is realized that the N-length groups were given candy only 50% of the time that they chose to give candy in the acquisition phase and 0% of the time in the extinction phase. Even the 100% reinforcement group received candy only in the acquisition phase. This high level of cooperative responding between Negro males suggests that there may be population differences and that future research of this type should sample other ethnic populations. Also, Manning, Pierce-Jones and Parelman (1968) using a similar type of game but without an extinction phase found that Anglo females responded differently from females of other ethnic groups. It also seems plausible that, had an extinction phase been used in this experiment, other ethnic group differences might have become apparent.

In order to compare the behavior designated as cooperative in this study with the degree to which the children were actually cooperative in their daily life, a Pearson product moment coefficient of correlation was computed between the proportion of cooperative responses that each child made throughout the experiment and a teacher rating of cooperativeness. These teacher ratings were made by requesting one of the day care center teachers to assign a rating from one to ten to each child, with a rating of ten representing an ideally cooperative child. For all 80 subjects combined there was a correlation coefficient of .23 which is significant beyond the .05 probability level.

If one wishes to generalize these results beyond the experimental conditions of this study, there are several practical implications. It seems that children should not always be rewarded by their peers, parents, and teachers for their cooperative efforts if a lasting cooperative orientation towards others is to be developed. However, a teacher or a parent should be sensitive to the way a child is reacting to others when he is not immediately praised for his cooperative efforts. In other words, much of the child's cooperative behavior should be taken for granted as a normal and expected way of responding to others. This type of attitude towards the child should be maintained up to the point where the child begins to think that his efforts are going unnoticed, and then praise and reciprocation would be appropriate.

REFERENCES

Amsel, A. The role of frustrative nonreward in noncontinuous reward situations. Psychological Bulletin, 1958, 55, 102-119.

Azrin, N. H., & Ogden, R. L. The reinforcement of cooperation between children. Journal of Abnormal and Social Psychology, 1956, 52, 100-102.

Bijou, S. W. A systematic approach to an experimental analysis of young children. Child Development, 1955, 26, 161-168.

Black, R. W., & Spence, K. W. Effects of intertrial reinforcement on resistance to extinction following extended training. Journal of Experimental Psychology, 1965, 70, 559-563.

Brotsky, S. J., & Thomas, K. Cooperative behavior in preschool children. Psychonomic Science, 1967, 9(6), 337-338.

Brown, P., & Elliott, R. Control of aggression in a nursery school class. Journal of Experimental Child Psychology, 1965, 2, 103-107.

Bruning, J. L. Effects of magnitude of reward and percentage of reinforcement on a lever movement response. Child Development, 1964, 35, 281-285.

Capaldi, E. J. Effect of N-length, number of different N-lengths, and number of reinforcements on resistance to extinction. Journal of Experimental Psychology, 1964, 68, 230-239.

Capaldi, E. J. Partial reinforcement: an hypothesis of sequential effects. Psychological Review, 1966, 73, 459-477.

Capaldi, E. J. A sequential hypothesis of instrumental learning. Psychology of Learning and Motivation. Vol. 1, 1967, Academic Press Inc., New York, 67-156.

Capaldi, E. J., & Hart, D. J. Influence of a small number of partial reinforcement training trials on resistance to extinction. Journal of Experimental Psychology, 1962, 64, 166-171.

Capaldi, E. J., & Senko, M. G. Acquisition and transfer in partial reinforcement. Journal of Experimental Psychology, 1962, 63, 155-159.

Capaldi, E. J., Hart, D., & Stanley, L. R. Effect of intertrial reinforcement on the aftereffect of nonreinforcement and resistance to extinction. Journal of Experimental Psychology, 1963, 65, 70-74.

Capaldi, E. J., & Wargo, P. Effect of transitions from nonreinforced to reinforced trials under space-trial conditions. Journal of Experimental Psychology, 1963, 65, 318-319.

Capaldi, E. J., & Spivey, J. E. Intertrial reinforcement and after-effects at 24-hour intervals. Psychonomic Science, 1964, 1, 181-182.

Capaldi, E. J., & Deutsch, E. A. Effects of severely limited acquisition training and pretraining on the partial reinforcement effect. Psychonomic Science, 1967, 9(3), 171-172.

Capaldi, E. J., & Oliver, W. P. Effect of intertrial reinforcement following a substantial number of consistently rewarded trials. Journal of Experimental Psychology, 1967, 75(1), 135-138.

Evans, P. K., & Endsley, R. C. Effects of three reward-nonreward ratios on discrimination learning in pre-school children. Journal of Experimental Child Psychology, 1966, 4(2), 143-149.

Fattu, N. A., Mech, E. V., & Auble, D. Partial reinforcement related to "free" responding in extinction with preschool children. Journal of Experimental Education, 1955, 23, 365-368.

Gallo, Phillip S., & McClintock, C. G. Cooperative and competitive behavior in mixed motive games. Journal of Conflict Resolution, 1965, 9(1), 68-78.

Grosslight, J. H., & Child, I. L. Persistence as a function of previous experience of failure followed by success. American Journal of Psychology, 1947, 60, 378-387.

Hulicka, I. M., Capehart, J., & Viney, W. The effect of stimulus variation on response probability during extinction. Journal of Comparative and Physiological Psychology, 1960, 53, 79-82.

Jenkins, W. O., & Stanley, J. C. Partial reinforcement: a review and critique. Psychological Bulletin, 1950, 47, 193-234.

Lachman, R. The influence of thirst and schedules of reinforcement-nonreinforcement ratios upon brightness discrimination. Journal of Experimental Psychology, 1961, 62, 80-87.

Lester, D. Determinants of resistance to extinction after three training trials: I. Chronological age and mental age. Psychological Reports, 1966, 19, 970. (a)

Lester, D. Partial reinforcement effect after a small number of training trials. Psychological Reports, 1966, 19(3, pt. 2), 1335-1336. (b)

Lester, D. Determinants of resistance to extinction after three training trials: II. The child's expectations. Psychological Reports, 1967, 20(2), 421-422.

Lewis, D. J. Partial reinforcement: a selective review of literature since 1950. Psychological Bulletin, 1960, 57(1), 1-28.

Logan, F. A., & Wagner, A. R. Reward and Punishment. Boston: Allyn and Bacon, 1965.

Loh, Wallace. Operant conditioning of cooperative behavior in children. Cornell Journal of Social Relations, 1966, 1(2), 85-94.

Manning, B. A. Cooperative behavior as a function of attitude similarity-dissimilarity and of temptation to defect from a cooperative strategy in a two-person, mixed-motive, nonzero-sum game. Unpublished master's thesis, University of Texas, 1965.

Manning, B. A., Pierce-Jones, J., & Parelman, R. L. Cooperative, trusting behavior as a function of ethnic group similarity-dissimilarity and of immediate and delayed reward in a two-person game. Final Report to the Office of Economic Opportunity, August, 1968, Child Development Research and Evaluation Center, (Southwest), University of Texas, Contract No. OEO-4115.

McCain, G., Reed, C., & McCormack, L. Extinction after a small number of partial reinforcement trials. Psychological Reports, 1963, 13, 300.

Parker, R. K. Effects of instructions, schedules of reward, and magnitude of reward on the discrimination of acquisition and extinction phases of learning. Journal of Experimental Psychology, 1967, 75(2), 210-216.

Parker, R. K., & Nunnally, J. C. Association of neutral objects with rewards: effects of reward schedules on reward expectancy, verbal evaluation, and selective attention. Journal of Experimental Child Psychology, 1966, 3(4), 324-332.

Patterson, G. R., & Hinsey, W. C. Investigations of some assumptions and characteristics of a procedure for instrumental conditioning in children. Journal of Experimental Child Psychology, 1964, 1(2), 111-122.

Pederson, David R. Associative versus motivational interpretations of reward percentage effects on children's performance. Psychonomic Science, 1967, 8(4), 139-140.

Penny, R. K. The effects of non-reinforcement on response strength as a function of number of previous reinforcements. Journal of Canadian Psychology, 1960, 14, 206-215.

Rapoport, A. Critiques of game theory. Behavioral Science, 1959, 4(1), 49-66.

Ryan, T. J., & Voorhoeve, A. C. A parametric investigation of reinforcement schedule and sex of subject as related to acquisition and extinction of an instrumental response. Journal of Experimental Child Psychology, 1966, 4(2), 189-197.

Ryan, T. J., & Watson, P. Frustrative nonreward theory applied to children's behavior. Psychological Bulletin, 1968, 69(2), 111-125.

Semler, I. J., & Pederson, D. R. Children's reactions to nonreward: partial vs. continuous reinforcement using a within-subjects design. Psychonomic Science, 1968, 10(8), 285-286.

Sheffield, V. F. Extinction as a function of partial reinforcement and distribution of practice. Journal of Experimental Psychology, 1949, 39, 511-526.

Shubik, Martin (Ed.) Game Theory and Related Approaches to Social Behavior. New York, London, Sydney: Wiley and Sons, 1964.

Spence, K. W., Platt, J. , & Matsumoto, R. Intertrial reinforcement and the partial reinforcement effect as a function of number of training trials. Psychonomic Science, 1965, 3(5), 205-206.

Viney, W., Hulicka, I., Bitner, J., Raley, C. L., & Brewster, P. Effect of stimulus variation upon resistance to extinction in kindergarten children. Journal of Comparative and Physiological Psychology, 1968, 65(3, pt. 1), 539-541.

Watson, P., & Ryan, T. J. Duration of the frustration effect in children. Journal of Experimental Child Psychology, 1966, 4(3), 242-247.

Wilson, K. V., & Bixenstine, E. Forms of social control in two-person, two-choice games. Behavioral Science, 1962, 7(1), 92-102.